

ANALYSIS OF AERIAL IMAGES TO PROTECT MARINE ECOSYSTEMS

“IMPROVING PRECISION & VISUALIZATIONS”

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M1 Computer Science (Artificial intelligence)

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AGENDA

- Introduction
- Last Semester's Seascape
- Research and Methodology
- Data Preparation
- Optimizing Area Measurement
- Model Recommendation System
- Heatmap
- User Interface
- Accuracy Evaluation
- Results and Discussion
- Challenges
- Conclusion
- Acknowledgement
- References

INTRODUCTION

- Maritime surveillance and protection of Posidonia
- Marine Environments and Coastal Ecosystems
- Continuing the previous semester's initiative
- Improving measurements and enhancing analysis using advanced AI



LAST SEMESTER'S SEASCAPE

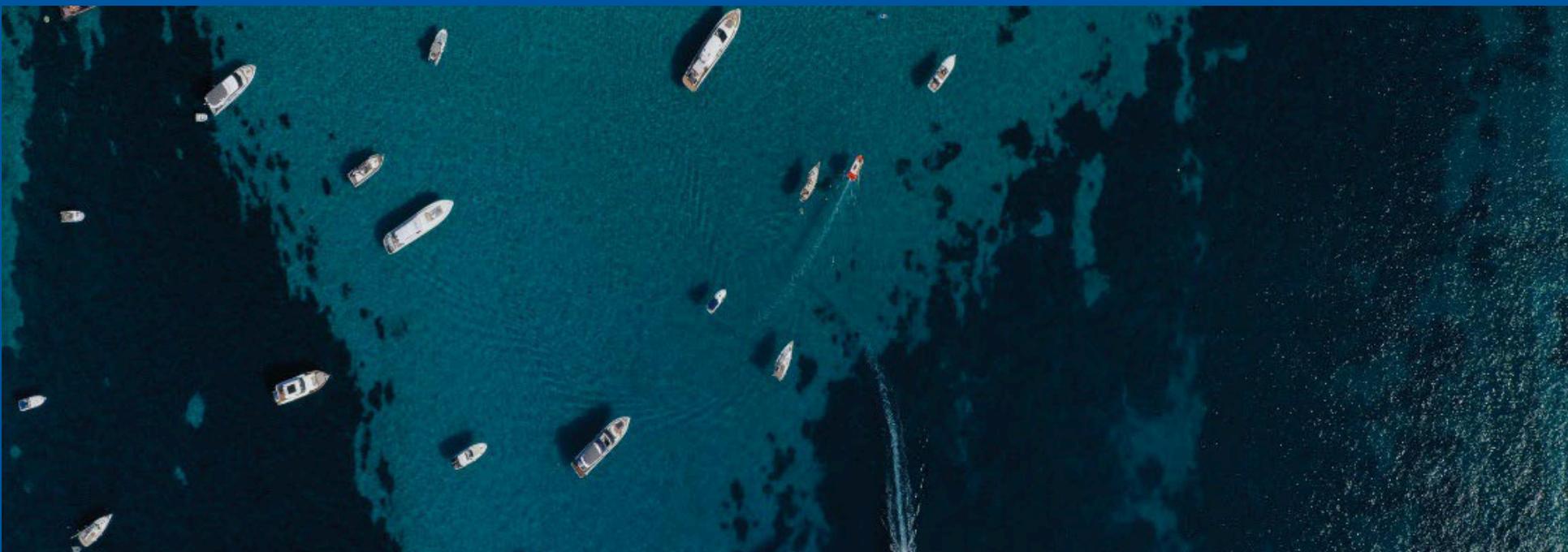
DETECTION AND CLASSIFICATION



DATA PREPARATION

SOURCE OF DATABASE

- Aerial images gathered from drone in 2021 and 2023



- Kaggle "Boats_dataset" containing detailed specifications of boat models

type	boatClass	make	model	year	condition	length_ft	beam_ft	dryWeigh	hullMater	fuelType	numEngin
power	power-center	Glasstrear	240 CCX	2020	new	24	8.25	3300	fiberglass	gasoline	1
power	power-bay	Glasstrear	228 Bay To	2020	new	22.83	8	2300	fiberglass	gasoline	1
power	power-center	Glasstrear	221 CC	2020	new	22	8.08	NA	composite	gasoline	1
power	power-center	Glasstrear	221 CC	2020	new	22	8.08	2300	composite	gasoline	1
power	power-skiwake	Mastercraft	Xstar	2019	new	23	8.5	5800	fiberglass	gasoline	1

PRE-PROCESSING

Meticulous refinement of the Kaggle dataset, including:

- Removal of redundant columns like: year, condition, fuel type, ...
- Elimination of duplicate entries
- computing and adding boat areas in square meters

id	type	boatClass	make	model	length_ft	beam_ft	dryWeight	hullMaterial	numEngines	engineCategory	length_m	beam_m	Area_m2
7016498	power	power-ceil	Glasstreear	240 CCX	24	8.25	3300	fiberglass	1	outboard	7.3152	2.5146	18.3948
5841592	power	power-ba	Glasstreear	228 Bay Tc	22.83	8	2300	fiberglass	1	outboard	6.958584	2.4384	16.96781
4442873	power	power-ceil	Glasstreear	221 CC	22	8.08		composite	1	outboard	6.7056	2.462784	16.51444
6834355	power	power-ski	Mastercra	Xstar	23	8.5	5800	fiberglass	1	inboard	7.0104	2.5908	18.16254
7271315	power	power-po	Starcraft	SLS-1	20	8.5	1921	aluminum	1	outboard-	6.096	2.5908	15.79352
7271334	power	power-po	Starcraft	EX 22 FD	22.75	8.5	2100	aluminum	1	outboard-	6.9342	2.5908	17.96513
7162591	power	power-otl	Sea Ray	SDX 270 O	27			fiberglass	1	outboard	8.2296	0	0
7271322	power	power-po	Starcraft	LX 22 R	22	8	2027	aluminum	1	outboard-	6.7056	2.4384	16.35094
7231525	power	power-sal	Scout	235 Dorad	23.67	8.5		composite	1	outboard-	7.214616	2.5908	18.69163

RESEARCH AND METHODOLOGY

- improving area measurement accuracy
 - morphology techniques
 - Refining the formula converting pixel dimensions to real-world measurements
- Boat model prediction
- Heatmap Development

OPTIMIZING AREA MEASUREMENT

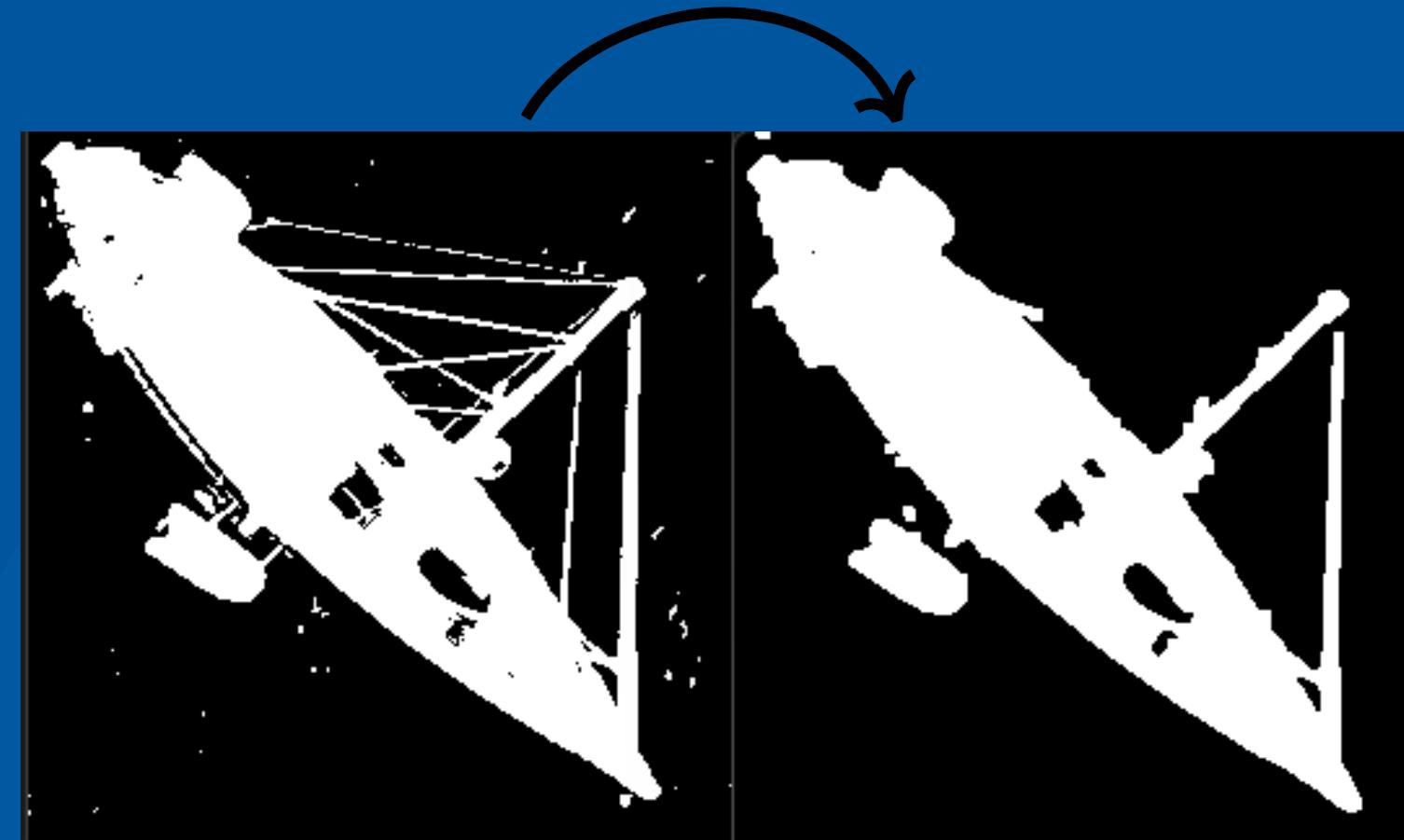
DYNAMIC ENVIRONMENTAL PARAMETERS

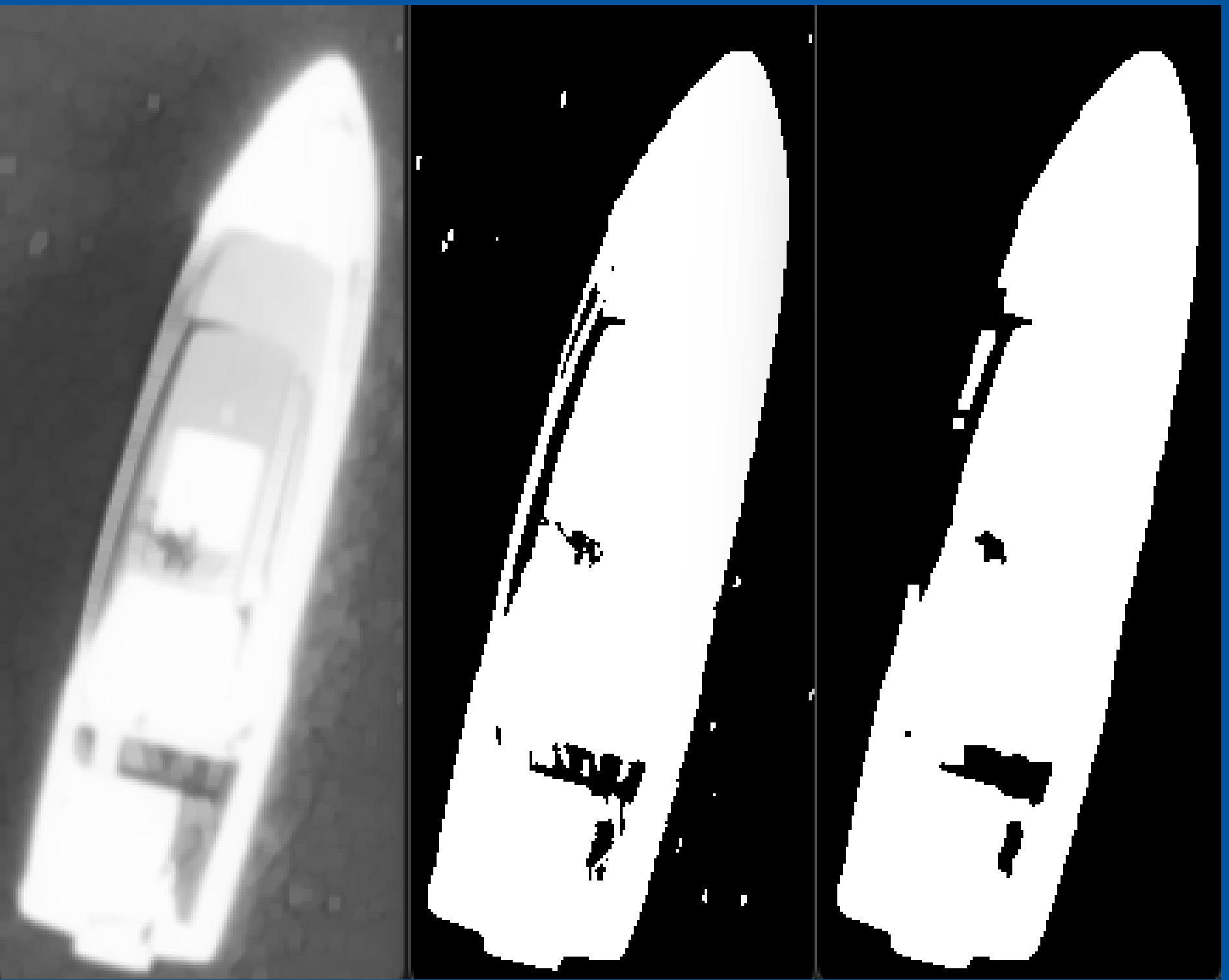
- Improving accuracy and adaptability of boat pixel extraction
- Morphology function now uses adjusted parameters to dynamically set kernel size and threshold values for varying lighting conditions.



NOISE REDUCTION

- Morphological Techniques Enhancement: Improving accuracy and adaptability of boat pixel extraction in the updated script.
- Applies Gaussian blur to grayscale ROI before morphological operations for noise reduction and improved image quality.





PIXEL DIMENSION CONVERSION

- Ground Sample Distance (GSD) calculation
- Instead of computing GSD separately for X and Y dimensions, the new version calculates the average pixel size and utilizes it directly

```
# Calculating boat area
boat_area_pixel = np.count_nonzero(res)

Pixel_Size_X=sensor_size[0]/imgsize[0]
Pixel_Size_Y=sensor_size[1]/imgsize[1]
Average_Pixel_Size=(Pixel_Size_X+Pixel_Size_Y)/2

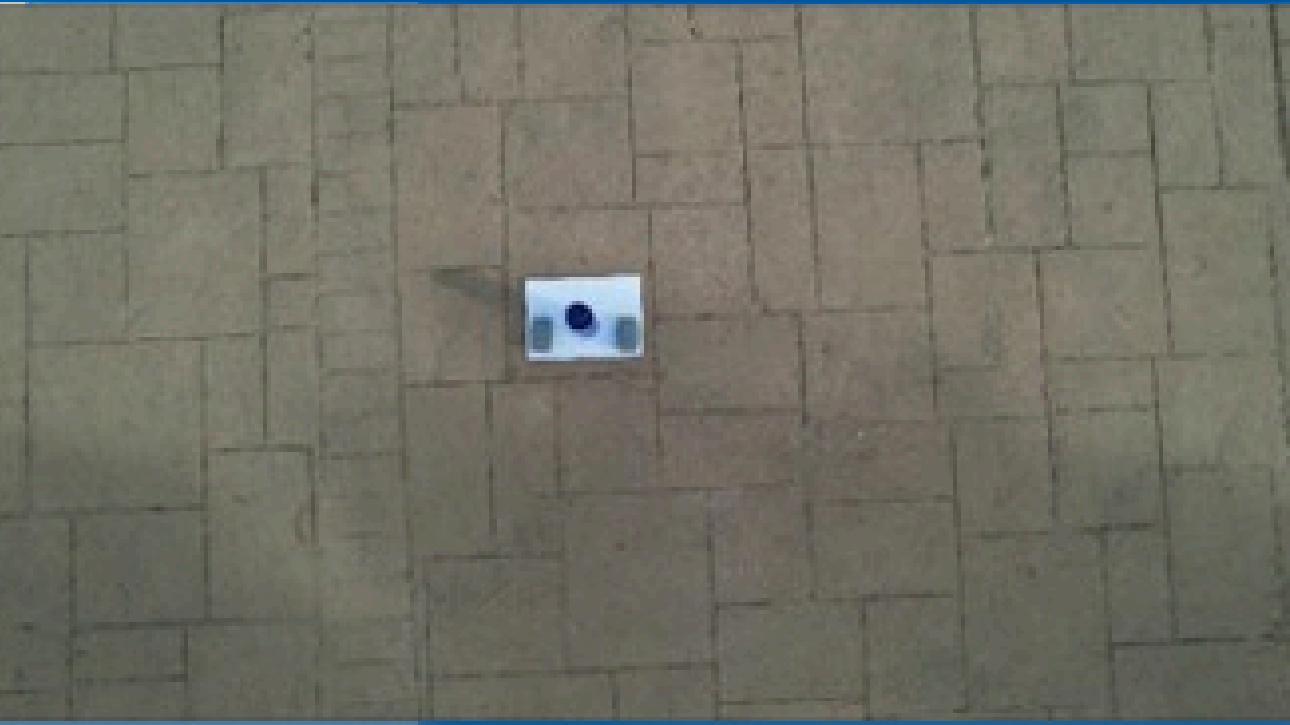
gsd = Average_Pixel_Size * altitude / focal_length

# Convert pixel coordinates to real-world coordinates
area = boat_area_pixel * (gsd ** 2)
```

ACCURACY EVALUATION

Utilized an innovative technique suggested by Professor Martinet involving a drone positioned at heights of 10, 20, 30, and 40 meters.

- Procedure:
 - Recorded footage of a piece of A4 paper with a known area
 - Extracting frames and pinpointing the object's location
- Analysis:
 - Isolated pixels corresponding to the paper in the images using morphological component analysis, feeding pixel count, camera specs, and photo metadata into area calculation function.



calculated area: 645 cm²
Real area: 623 cm²
Absolute Error: 22.87555685161078 cm²
Relative Error: 3.671838980996915 %

MODEL RECOMMENDATION SYSTEM

Recommending boat models based on their respective areas

- "Boats_With_Area_mm2.csv" & "boats.csv" containing details about boat models and calculated areas in a given image.
- $\pm 3.6\%$ error margin for boat area to determine similar models.
- Information boat IDs, models, areas, maker, number of engines and
- Recommendations are shown to the user for review and saved to a CSV file for future reference.

Detected boats:

	model	Area_m2
1	Mootor boat	76
2	Mootor boat	74
3	Mootor boat	69
4	Mootor boat	114
5	Mootor boat	46
6	Mootor boat	30
7	Mootor boat	315
8	Mootor boat	51
9	Moving boat	55
10	Mootor boat	16
11	Mootor boat	33
12	Moving boat	35

Recomended boats?(Y/N) y

* Boat number: 1 | Type: Mootor boat | Area: 76.68298165012935

Possible Models:

Hudson Bay 50 Sedan (power) - Area: 75.30 mm²

C52 Command Bridge (power) - Area: 75.70 mm²

48 Open (power) - Area: 75.81 mm²

48 Sport Coupe (power) - Area: 75.81 mm²

* Boat number: 2 | Type: Mootor boat | Area: 74.5324761724052

Possible Models:

Hudson Bay 50 Sedan (power) - Area: 75.30 mm²

C52 Command Bridge (power) - Area: 75.70 mm²

48 Open (power) - Area: 75.81 mm²

48 Sport Coupe (power) - Area: 75.81 mm²

Oceanis 51.1 (sail) - Area: 74.62 mm²

recommended boats

MB 0.91

(1):76 ***

detected boats number one



recommend boat model 50 Sedan

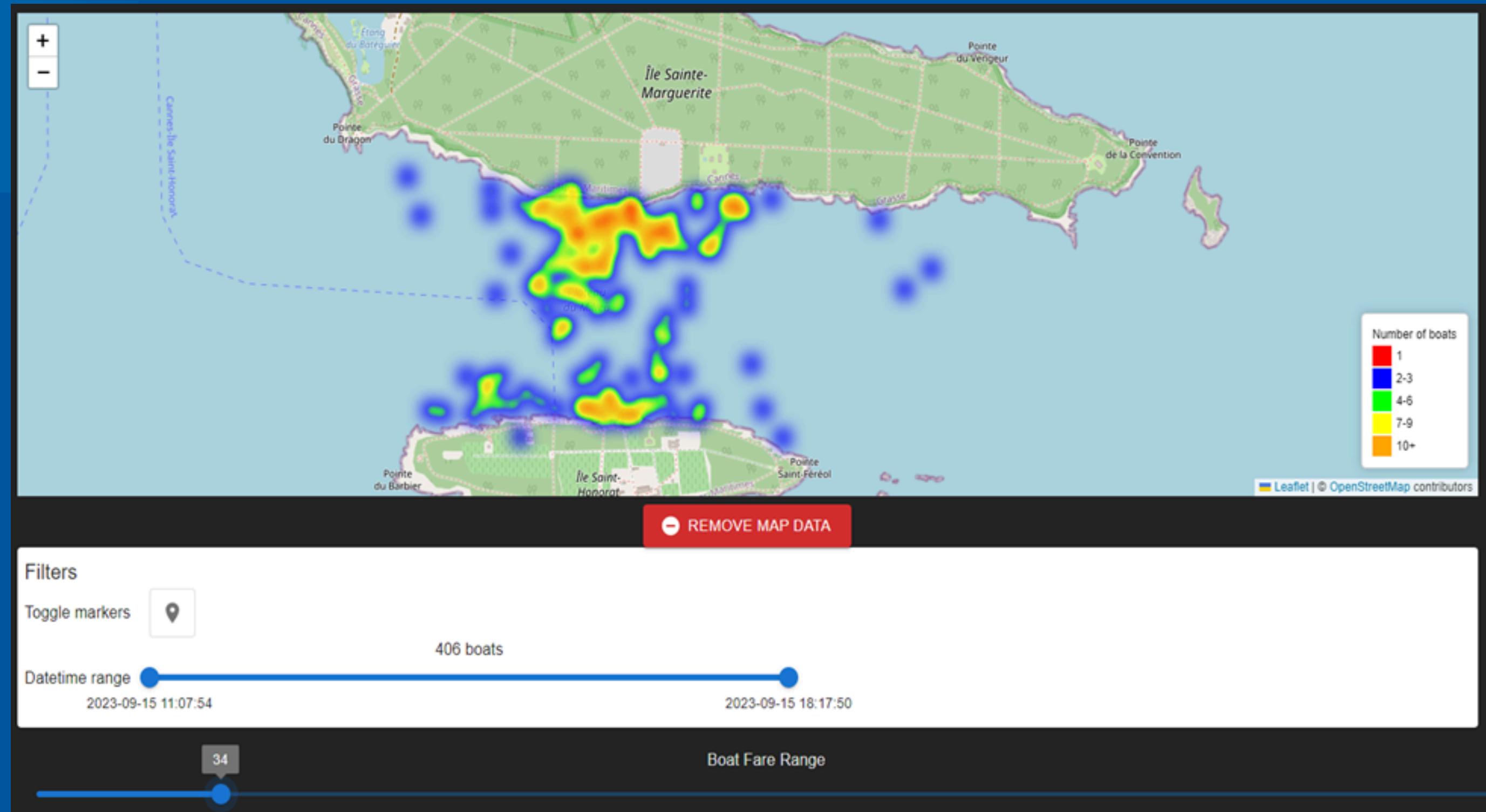


recommend boat model 48 Open

HEATMAP

Implementing a heatmap feature to visualize boat distribution based on size.

- Collaborative Effort
- Modifying boat detection component to generate a CSV file with boat locations, and include boat size information.
- Providing insights into boat activity dynamics, aiding in the protection of marine ecosystems, particularly Posidonia Oceanica habitats.



USER INTERFACE

Interactive Features: Users can make decisions regarding area calculation methods and set thresholds for classification.

- Area Calculation Options
- Setting Class Intervals
- Recommendation System

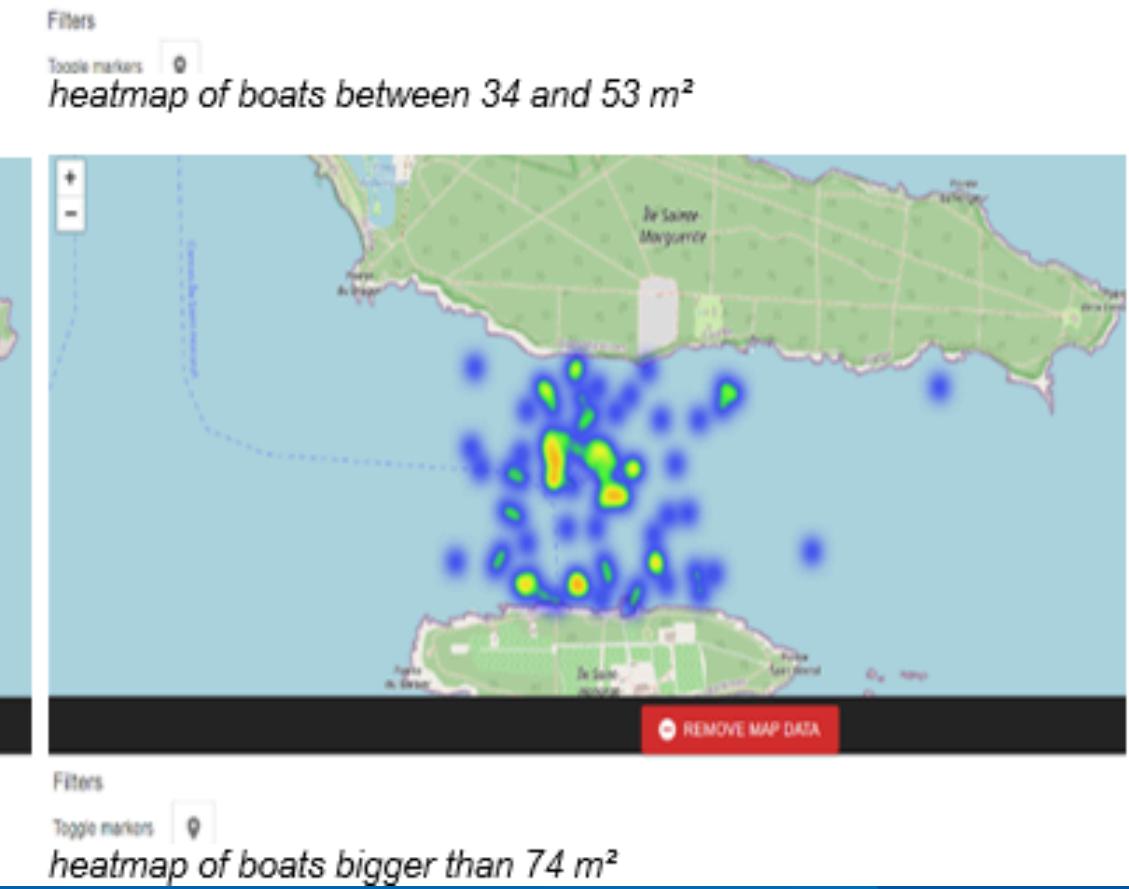
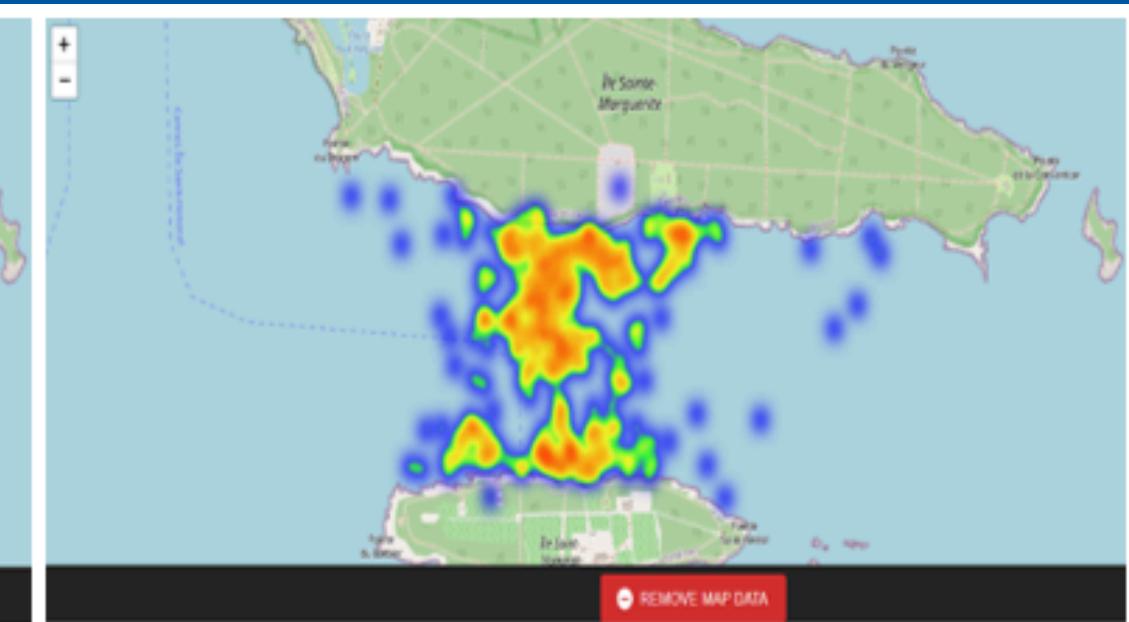
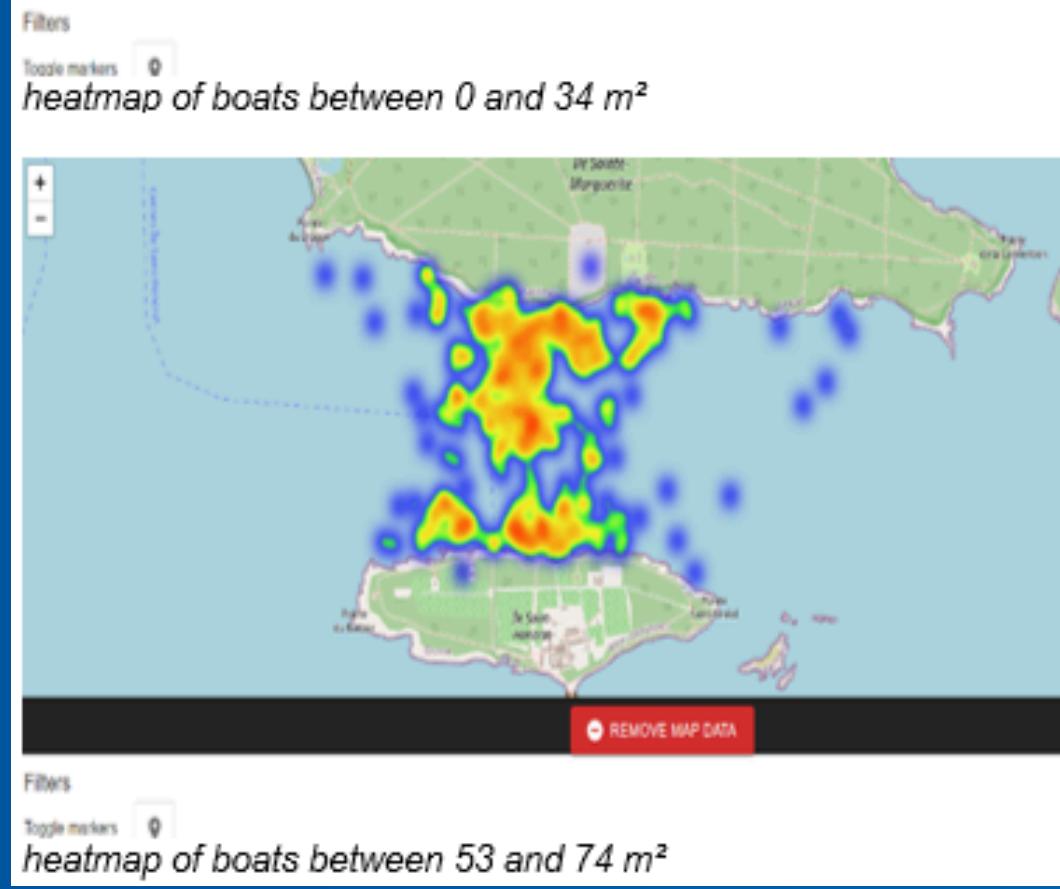
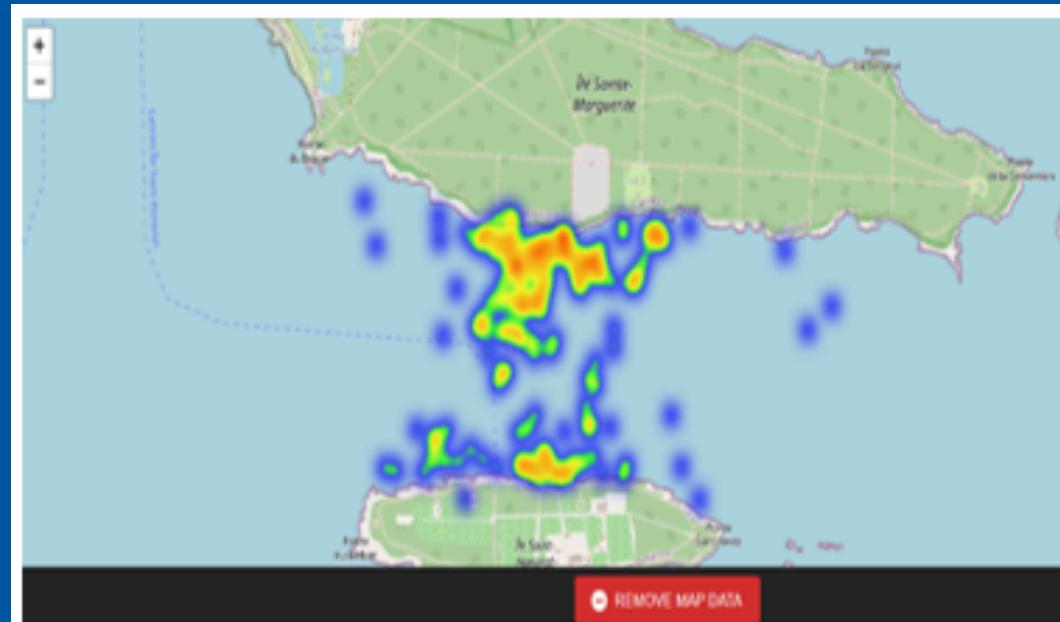
```
calculate the area using:  
1) Pixels  
2) boxes  
Your chois: 1
```

```
Determining intervals using:  
1) Database images  
2) Current input  
Your chois: 1
```

```
Are you using a new dataset?(Y/N) N
```

RESULTS AND DISCUSSIONS

- The distribution of boats within the Marine Protected area
- Correlation between Boat Size and Impact
- Importance of Identifying Pressure Zones
- From previous calculation error of $\pm 18\%$ to a much smaller error of $\pm 3.6\%$
- Reference for Precision: A benchmark for proposing boat models



CHALLENGES

- Technical issues, including hardware limitations
- Overcoming challenges
- Interdisciplinary nature of the project

CONCLUSION

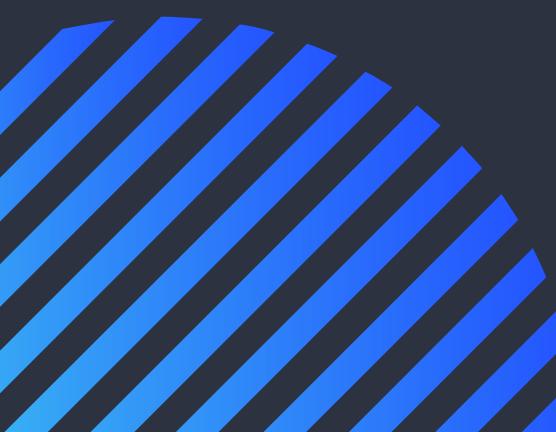
- The success of the project in boat detection and classification.
- Practical implications for marine students and environmental surveillance.
- Continuous refinement and application in real-world scenarios.

ACKNOWLEDGMENTS

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Thank you For your time

Extras

calculated area: 506.72688892883337 cm²

Real area: 623 cm²

Absolute Error: 116.27311197916663 cm²

Relative Error: 18.663420863429636 %